



Energy Research at UK

May 2007 EQC Meeting

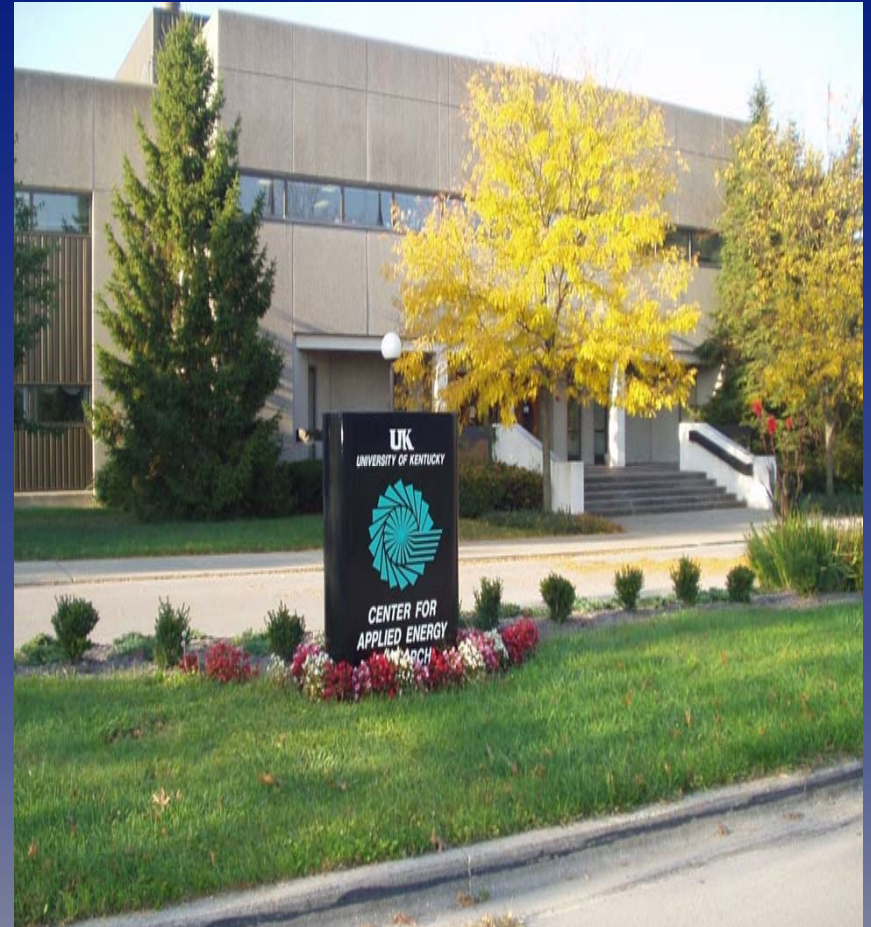
**University of Kentucky
Center for Applied
Energy Research**

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Agenda

-  **Overview of Various Areas of Energy Research at UK**
-  **Focus on the Center for Applied Energy Research**



UK Energy & Environmental Task Force

Six topic areas identified in which UK has important competencies:

- **Energy Supply**
- **Energy Conversion**
- **Energy and Environmental Quality**
- **Energy Efficiency and Sustainability**
- **Advanced Materials, Sensors and Controls**
- **Energy and Environmental Policy**





Energy Supply

- Resource assessment of coal/other.
- Equipment, mine design and reclamation.
- Advanced coal preparation.
- Slurry ponds/alternative waste coal disposal.
- Improvements in miner health and safety.
- Assessing potential for coalbed methane development and CO₂ sequestration.



- Improvements in combustion technologies.
- Research for gasification systems.
- Hydrogen production, storage and devices for H₂ use.
- Materials of construction, catalysis and membranes for fuel cells.
- Management of solid by-products from coal combustion (ash, FGD, slag).



Energy & Environmental Quality



- Greenhouse gas management - CO₂ reduction, capture, sequestration.
- Measurement, source apportionment, modeling and control of air emissions.
- Heavy metal contaminants in water.
- Water resources and quality.
- Living systems and human health effects.





Energy Efficiency & Sustainability

- **Industrial energy efficiency and waste minimization.**
- **Building/housing design and equipment for energy efficiency.**
- **Biofuels, bio-refining, and biomass for alternative transportation fuels and electric power generation.**



Advanced Materials, Sensors and Controls



- Carbon materials for sensors, composites, paints/coatings, gas storage, electrodes, and batteries.
- Ceramics: high temperature materials for fuel cells, electrodes, gas separation.
- Metals: direct casting of aluminum for high volume transportation applications.





Energy and Environmental Policy

- **Technical Policy Analysis** to assure that policy-making is informed by technical realities.
- **Market forces, economic policy and economic regulation.**
- **Matters of law and regulation: property rights; development rights; taking issues; regulatory, permitting and bonding; and enforcement.**
- **Research and service in energy and environmental policy formulation.**





CAER's Research Focus

- ***Applied*** – engineering –pilot/demo scale
- ***Resources*** - coal, oil shale, bio-fuels, H₂
- ***End-use*** - Electricity, fuels and chemicals, carbon materials
- ***At the plant*** – mines, utilities, refineries, mill



Mining

- Coal Prep/Cleaning
- Coal Slurry Ponds**
- Mine Mapping

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Electric Power

- Generation
- Emissions Control**
- Carbon Management
- Beneficial Re-use of By-products (ash, slag, FGD, etc.)**

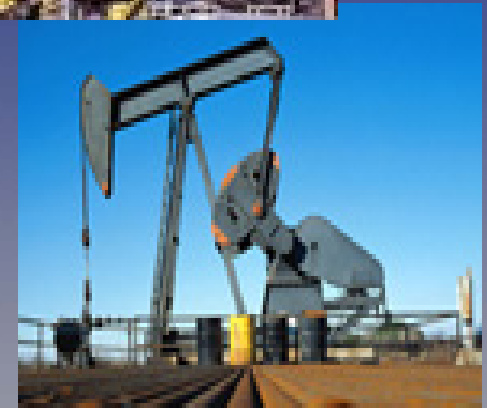
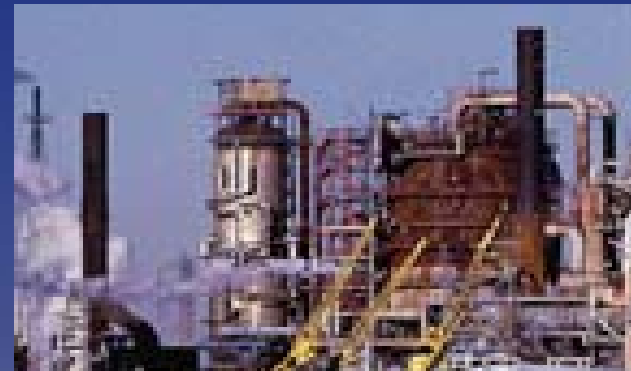




Applied Research

Fuels, Chemicals & Materials

- Coal-to-Liquids (CTL) Technologies
- Catalyst Research and Testing Center
- Oil Shale Retorting
- Carbon Materials
- Environmental Catalysis
- Agricultural Bio-fuels**
- Fuel Cells, Batteries and Devices

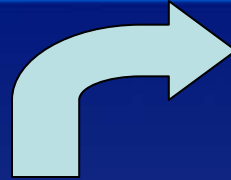


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Technology and Innovation

Can Lead to Eliminating Coal Slurry Ponds

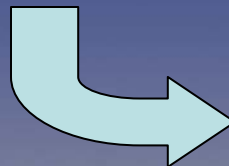
UK



**Coarse
waste
shale/ rock**



**Fine coal
waste**



650M tons potentially recoverable



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By Densification/Stabilization of Wastes



- *UK Deep Cone Thickener – produces paste for safe disposal*
- *Reduces water content from 75% to 45%*





By Converting Waste Coal to High Btu Fuel



•Product



- *Coal-equivalent fuel for power stations made of coal fines and saw dust*
- *Briquettes - 14,000 Btu/lb*



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Technology and Innovation



Can Lead to Beneficial Re-Use of Solids

Ash, Slag, FBC & FGD Materials

A \$500,000,000 Kentucky Industry

Roofing Granules from Cyclone Combustors

*500,000 Tons From Kentucky Sources, \$14,000,000 value
\$2.4 million in wages*



**Wallboard from
Flue Gas Scrubbers**

*450,000 Tons From Two
Kentucky Wallboard Plants
\$60,000,000 in Wages
\$190,000,000 Product Value*

Concrete Additive from PCC Fly Ash

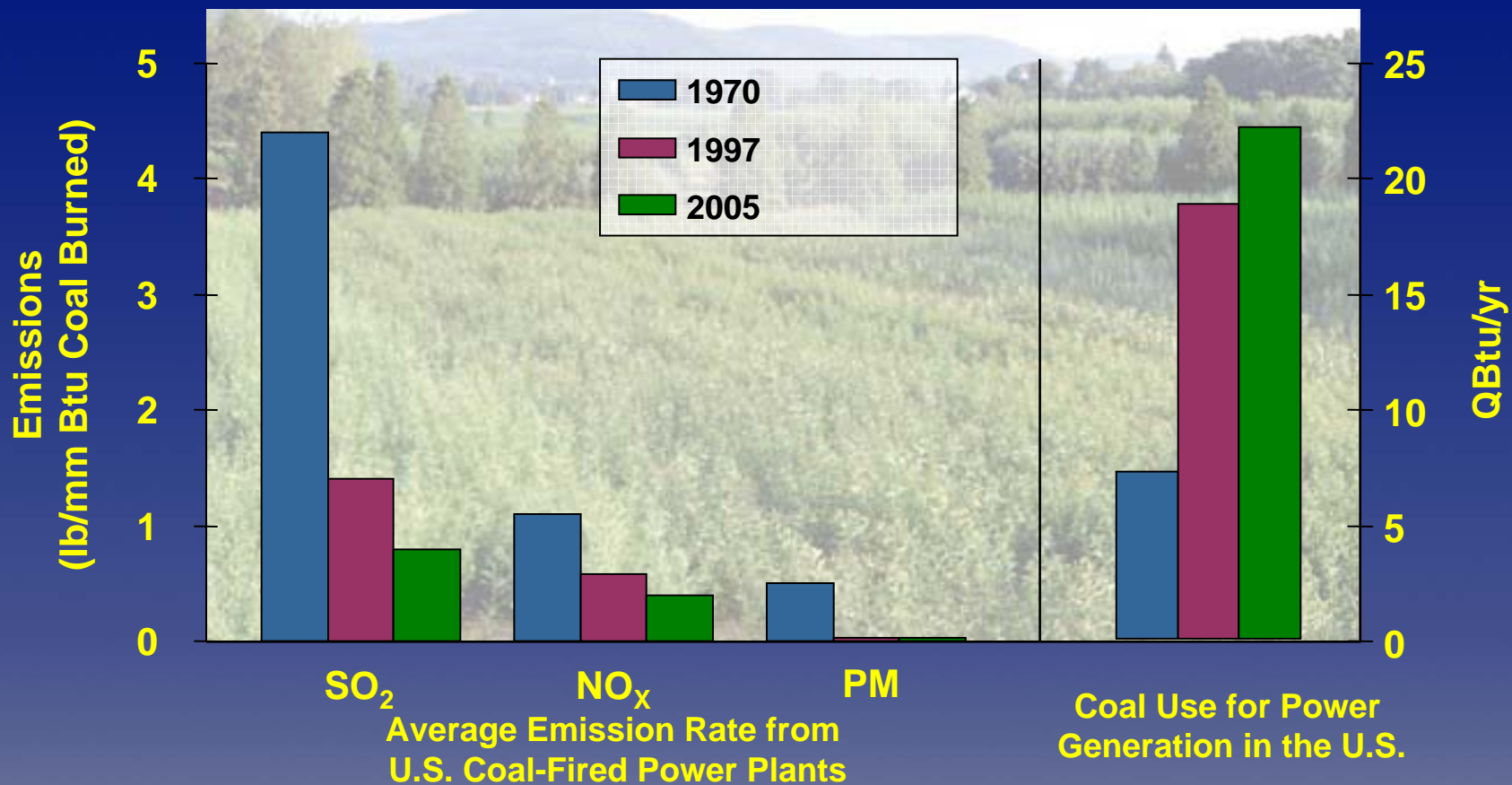
100,000 Tons From Kentucky Sources, \$1.6 million value



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Technology and Innovation *Can Lead to Reductions in Primary Pollutants*



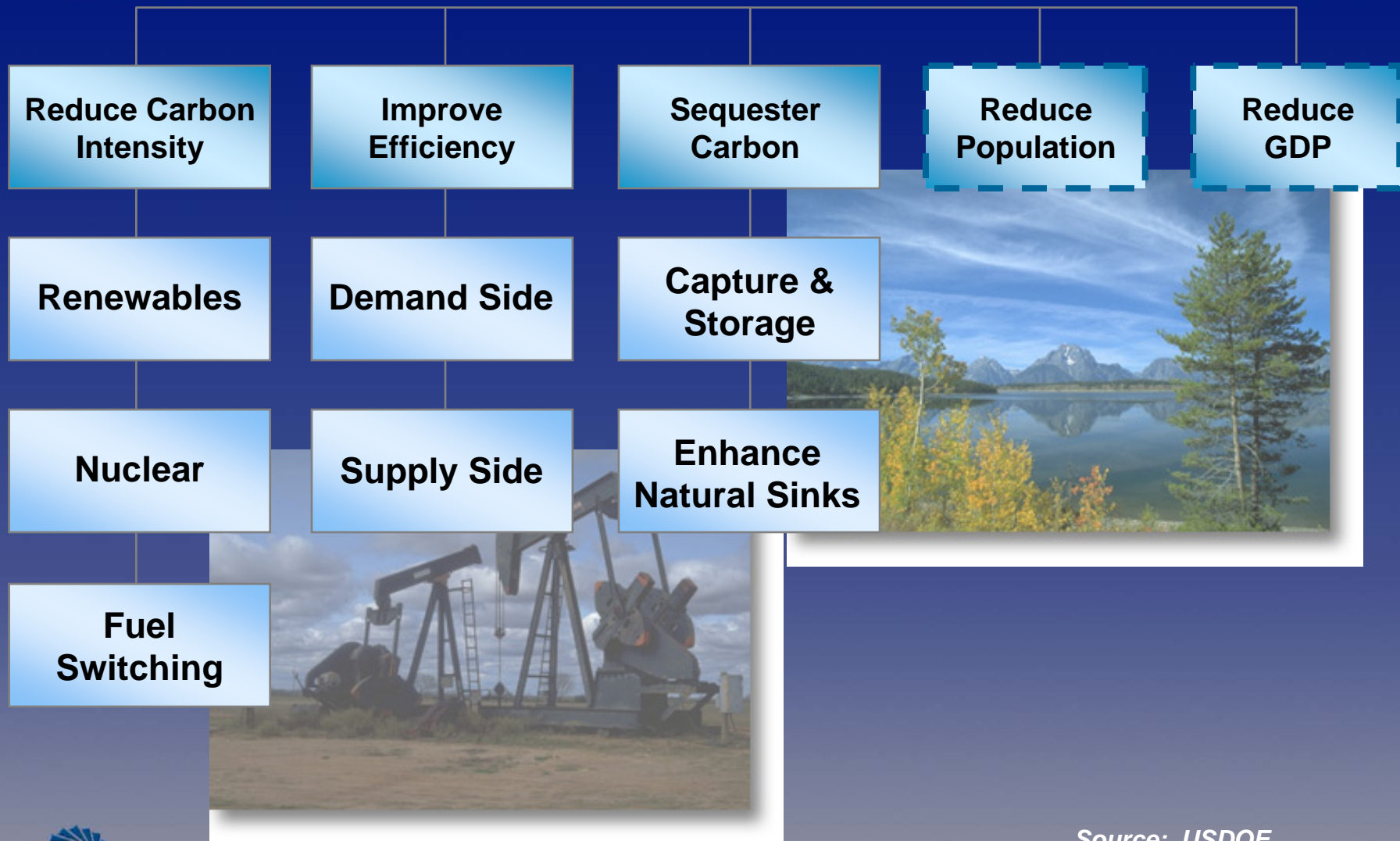
**Emissions Per Unit of Coal
Burned Have Decreased Significantly**



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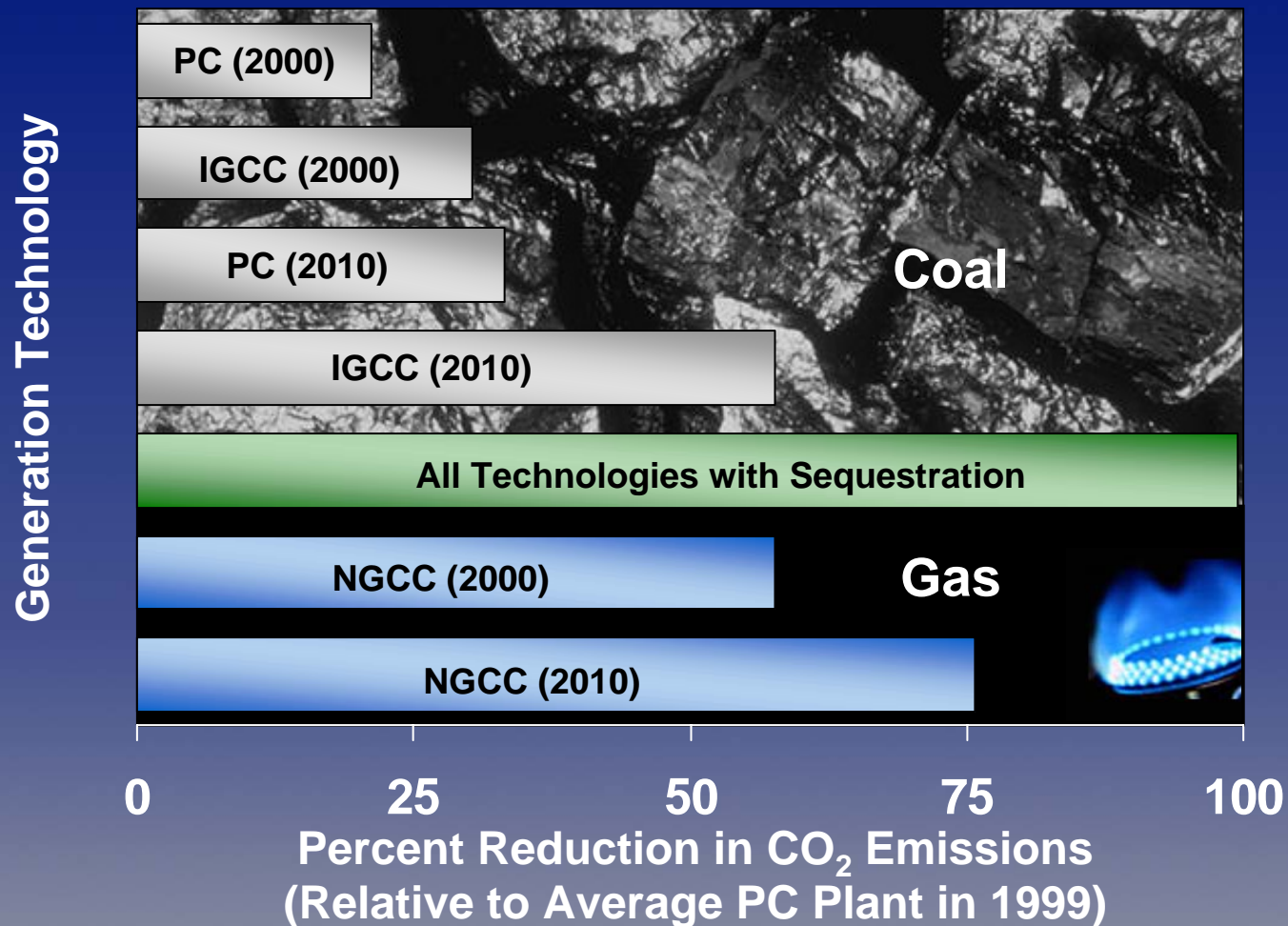
Source: USDOE

UK **Technology and Innovation** *Can Lead to Reductions in Carbon Emissions*





By Adoption of New Power Generation Technologies





By Switching to the Alternatives

Wind, hydro, and
geothermal - Not
enough

Biomass - Transportation,
land use, expense

Solar - Land use, capital
cost, storage

Nuclear - Expense,
politically taboo,
proliferation issue

Hydrogen - cost



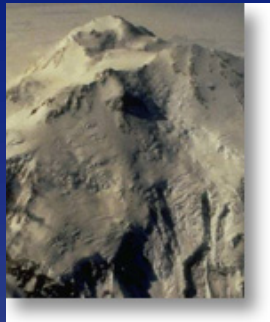
Needed: An Affordable, Clean, and Abundant Energy Source
No Known Source Meets These Criteria





By Carbon Sequestration

Direct



Unmineable
Coal Seams



Capture and Disposal of CO₂



Deep Ocean
Injection

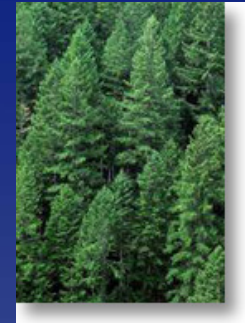


Depleted Oil /
Gas Wells,
Saline Aquifers

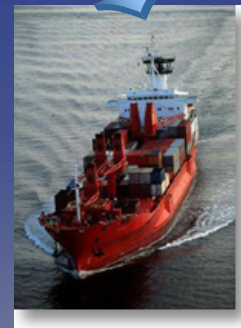
Indirect



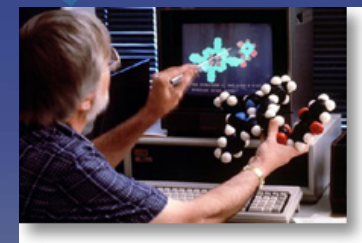
Enhancing Natural CO₂ Sinks



Forestation



Iron or Nitrogen
Fertilization of
Ocean



Enhanced
Photosynthesis

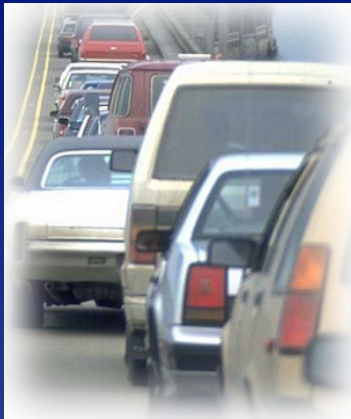


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Source: USDOE



By Efficiency and Personal Responsibility



- **Park your SUV**
- **Take the Bus**
- **Buy the “Hybrid”**
- **Pay a Higher Price at the Pump**
- **Demand CAFE**



- **Insulate your house**
- **Thermal-insulating windows**
- **High efficiency appliances**
- **Water-saving devices**
- **Natural lighting/solar mass**



- **Encourage industrial efficiency**
- **“Green” chemistry**
- **Recycle your waste**



- **Eat lower on the food chain**
- **Get closer to your food**



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Thought for the Future

UK Near-zero Emission Electric Power



FutureGen

(Artist rendering)



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